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Economic Research-Ekonomska Istraživanja

ISSN: 1331-677X (Print) 1848-9664 (Online) Journal homepage: http://www.tandfonline.com/loi/rero20

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To cite this article: İlhan Eroglu, Mehmet Çınar & Nadir Eroglu (2017) An evaluation of the effectiveness of an inflation targeting strategy in Turkey, Economic Research-Ekonomska Istraživanja, 30:1, 1536-1552, DOI: 10.1080/1331677X.2017.1340172

To link to this article: https://doi.org/10.1080/1331677X.2017.1340172

Published online: 28 Jun 2017.

ECONOMIC RESEARCH-EKONOMSKA ISTRAŽIVANJA, 2017
VOL. 30, NO. 1, 1536–1552
https://doi.org/10.1080/1331677X.2017.1340172

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An evaluation of the effectiveness of an inflation targeting strategy in Turkey

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ABSTRACT

In this research, the performance of inflation targeting strategy was analysed using the least square method (LSM) with the regression model for economic circumstances in Turkey. The results of this research can be summarised as follows: (1) Inflation targeting regime has a weak positive effect on inflation rate performance; (2) There is no significant relationship between inflation targeting regime and growth rate; (3) There is a positive but a weak relationship between inflation targeting regime and exchange rate performance; and (4) Inflation targeting regime has a strong positive effect on nominal interest rate performance. Thus, these results support the argument in the literature that 'inflation targeting affects macroeconomic performance positively except for growth rate'. Thus, the post-2002 inflation-targeting regime, whether rule-based or occasional, has led to some improvements in other macroeconomic indicators, even though the primary aim of monetary policy instruments is to bring down the rate of inflation. Such stability-assuring policies enable investors to invest in a more trustable environment.

ARTICLE HISTORY
Received 28 April 2015
Accepted 8 March 2017

KEYWORDS
Inflation; inflation targeting; price stability; performance analysis

JEL CLASSIFICATIONS
E50; E52; E58

1. Introduction

Inflation-targeting, as a monetary policy strategy, became an issue in Turkey during the crises in November 2000 and February 2001, following the failure of the exchange-rate targeting strategy. It was been adopted after the crisis in February 2001 as a part of the 'Programme for Transition to a Strong Economy', which was put into force for the period 2002–2004.

In the literature, there are studies that suggest that inflation targeting has a positive impact on the macroeconomic performance in developed countries. However, in developing countries, it has been unsuccessful, depending on the failure to fulfil the required conditions. With the transition to the inflation-targeting strategy in Turkey, there have been numerous academic and political debates on the issue. This study aims to assess the performance of the

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strategy in Turkey through an econometric model. In this framework, we will first give the theoretical dimension of inflation targeting and its place in monetary policy. Then, we will make a general assessment on the conditions of the inflation-targeting strategy in Turkey. Last, the impacts of the strategy on macroeconomic variables (inflation rate, growth rate, rate of change in exchange rate, nominal interest rate) will be examined with a Least Squares Method-based (LSM) regression analysis through an empirical application along with the periods before and after the adoption of this strategy.

2. Theoretical dimension of inflation targeting

In most of the studies on the inflation-targeting strategy, numerous similar definitions can be found. However, Mishkin's (2000a, p. 10) definition gathers early different definitions in a single statement:

> It is a monetary policy strategy in which a medium-term numerical target is set for inflation, the primary goal of monetary policy is to assure price stability and no other monetary target is pursued, and the transparency and accountability of the central bank is attained.

In commenting on inflation targeting, it is necessary to present the political framework of this strategy and to look at which school of economics it has been derived from. It is important, when explaining the theoretical grounds of inflation targeting, to consider the distinctions between real and nominal variables and between the short- and long-term since the fact that monetary policies have no impacts on nominal and real variables simultaneously (due to lag effect and wage-price rigidities) necessitate the distinction between the short- and long-term with respect to the effects of the implemented policies[1] (Eroğlu, 2009, p. 69). While monetary policies have an impact on prices and production in the short-term, they influence the general level of prices only in the long-term. Thus, in order to decrease the difference of influence that is contingent upon duration and to establish the influence of monetary policy on real variables, the question 'Which policy is optimal?' has always been among the main issues in economic circles (Eroğlu, 2009, p. 70). The consequence of these debates is that a new approach has emerged as the optimal policy choice that attaches importance to stability between real and nominal variables and is based on the amalgamation of rational expectations (Rational Expectations Theory), which is a product of the Classical Approach, and wage-price rigidities (Neo-Keynesian Theory), which is a product of the Keynesian side (Büyükakın, 2007, p. 32). In other words, the quests for macroeconomic models suitable for the developments in the monetary policy literature and for the target of price stability have brought about a convergence[2] between the neoclassical-real business cycle and the Neo-Keynesian approach (Eroğlu, 2009, p. 70).

As a result of this convergence, Neo-Keynesian economists did not return to Keynesian policies, which are discretionary, activist, fine-adjusting and preferred in aggregate demand management. Thus, the Keynesian economics deviated from its nature. This initiative resulted in its convergence to the Neoclassical approach (Büyükakın, 2007, pp. 32–33). The New Neoclassical Synthesis represents a unique approach by bringing Classical and Keynesian elements together (Goodfriend & King, 1997, p. 2). In this new approach, the neoclassical-real business cycle theory and the arguments of the Keynesian economics regarding the operation of the market mechanism (costly price adjustment, time differences in wage and price regulations, imperfect competition, coordination failures, operation of the labour, credit and commodities markets) are addressed in unity (Büyükakın, 2007,

p. 27). The new neoclassical synthesis has assembled the contributions of various schools, rather than being grounded on a certain school of economics. Arguably, this convergence removed the ideological contents of existing macroeconomic policies (Goodfriend & King, 1997, p. 3; Arestis & Sawyer, 2002, pp. 2–3). Inflation targeting is a discipline that sees price stability as the main objective and involves political elasticity oriented towards minimising the output gap (Oktar, 1998, p. 50). In parallel with this, Mishkin (2000b, p. 1) pointed to the fact that countries which adopted the inflation targeting strategy have attained low and stable inflation rates without experiencing a decline in production.

Is inflation targeting a discretion- or rule-based strategy? It is possible to find contrasting answers to this question. According to McCallum (2001, p. 38), inflation targeting is a rule-based strategy, that is, it is a policy aimed at achieving the targeted inflation rate. However, as suggested by Oktar (1998, pp. 49–52), it is necessary to see this strategy not as an unchangeable rigid policy, but as a monetary policy strategy that is 'more flexible than the policy approach that is changeable as occasions require'. In this respect, technically, the inflation targeting strategy does not provide the central bank with an implementation procedure like a simple and mechanical rule; but on the contrary, prescribes a political framework in which various structural economic models and all possible information are taken into consideration. In conclusion, such an approach is more accepted in economic circles. In addition, the inflation targeting ranging from the medium- to the long-term provides central banks with an opportunity to manoeuvre where they can act on discretion or they can consider variables like employment and exchange rate. Accordingly, as Bernanke and Mishkin (1997, p. 2) also suggest, the inflation targeting strategy is a monetary policy that is founded upon 'constrained discretion', and based on both rule- and discretion-based practices under a certain discipline without losing the monetary policy flexibility.

In this strategy, the central bank can react to unexpected and extraordinary situations regarding the economic functioning and can make the policy change required by the accepted optimal policies. Thus, this is viewed as a situation that renders inflation targeting superior to other monetary policy strategies. Hence, against the global financial crisis erupted in 2008, those central banks, which were implementing this strategy, were capable of taking the monetary policy measures required to reduce the negative effects of the crisis (Yılmaz, 2008, p. 5).

3. Evaluation of inflation targeting strategy in Turkey

Central Bank of the Republic of Turkey (CBRT), as also indicated in the *The General Framework of Inflation Targeting* published in 2005 and the main policy text published in 2006 under the name *Monetary and Exchange Rate Policy*, announced that it had adopted a model unique to Turkey by considering the experiences of other countries (CBRT, 2005, p. 1). Within the framework of the policy text mentioned below, the pre-conditions of the inflation targeting strategy are evaluated by taking into consideration Turkey's conditions.

Tight commitment to the target of price stability: In today's economies, price stability is on top of the duties that central banks are required to perform. In this respect, the Central Bank in Turkey was restructured and the main objective of the bank was defined in the Law numbered 4651 and dated 5 May 2001 as 'attaining price stability' (Official newspaper, 2001).

Independent and reliable central bank: There exists a close link between the independence of the central bank and price stability. The confidence in monetary policy practices of

the bank is stiffened thanks to the independence and inflation expectations decline (Akyazı, 2004, p. 237). As for the independence of CBRT, in the Item c of the Section II of the Article 4, a structure in monetary policy decisions that is away from the political atmosphere was established by stating:

> … The Bank shall, with the objective to achieve and maintain price stability, be authorized to utilize monetary policy instruments described in this Law and shall also be authorized to directly determine and implement other monetary policy instruments that it deems appropriate. (Official newspaper, 2001)

This regulation is also in parallel with the Article 104 of the Maastricht Treaty and the Article 21.1 that regulates the European System of Central Banks (ESCB) (ECB, 2004, p. 53; Savaş, 1999, p. 83).

Monetary policy decision-making process: With the Law numbered 4651, the Monetary Policy Committee (MPC) is established, which institutionalised the monetary policy decision-making process. With the transition to open inflation targeting (2006), MPC ceased to be a 'recommending' body and became a 'decision-maker' (CBRT, 2006, p. 16). MPC, when taking a decision regarding interest rates, began to benefit from a large information cluster that includes aggregate supply–demand equilibrium, indicators about the fiscal policy, monetary indicators and credit sizes, wage-employment-unit cost-efficiency developments, public and private sector pricing behaviours, inflation expectations, exchange rates and developments that might have impact on them, analysis of possible external shocks, and the projections obtained from the economic estimation system produced within the bank (Kara & Orak, 2008, p. 52). Thus, the asymmetry that persisted until 2006 was eliminated and an important step was taken towards the institutionalisation of CBRT and rendering decisions transparent.

Transparency-communication procedures and accountability: The regulations regarding the transparency and accountability of CBRT were made through the amendments in the Articles 42 and 22 of the Law No. 1211 by the Law No. 4651. The Article 42 was reorganised as follows: 'The Bank shall prepare periodical reports concerning monetary policy targets and implementations and disclose these information to public. The periods of the reports to be prepared, their scope and disclosure procedure shall be determined by the Bank' (Official newspaper, 2001). CBRT defined the above-mentioned report as Inflation Report, which was to be main communication instrument of the monetary policy and published four times a year; and designed this report as the most essential mechanism for transparency and accountability. Additionally, the Financial Stability Report, which was published in 2006, should also be considered in this regard. Yet another instrument of transparency and accountability is the Monthly Price Developments Report where monthly inflation data are evaluated. Moreover, as stated in the Article 42 of the Law No. 4651, The Bank was obliged to:

> … submit information to the Government in writing and inform the public disclosing the reasons of incapability to achieve the determined targets in due time published or the occurrence of the possibility of not achieving and the measures to be taken thereof. (Official newspaper, 2001)

Strong and developed financial markets: The foundation of the regulations made in Turkey with the aim of constructing strong and developed financial markets is subject to the Banking Law No. 4386 dated 23 June 1999. With this Law, the Banking Regulation and Supervision Agency (BRSA) was established as an autonomous body that is the sole organ to regulate, monitor and inspect the banking sector (DPT, 2002, pp. 68–69). In addition to

this regulation, several legal arrangements were also made as part of the 'Programme for Transition to a Strong Economy'. Moreover, in order to render durable the financial markets in Turkey and increase the chance of success of the inflation targeting strategy, it was aimed by maintaining the role of CBRT as 'the ultimate crediting authority' with the Law No. 4651 to ensure the effective functioning of financial markets and to prevent potential problems to be experienced in the banking sector.

Fiscal dominance: Special importance must be attached to fiscal dominance since it may lead to a risk of monetisation. This importance was also underlined by the Maastricht Treaty signed by 12 EU countries on 7 February 1992. According to the Treaty, budget deficits of EU countries should not exceed 3% of GDP and total public debt should not exceed 60% of GDP (Eroğlu, 2007, p. 10). The most important development in Turkey on the way to decreasing fiscal dominance was the 'Law numbered 4749 on Regulating Public Finance and Debt Management', which came into force after its publication in the *Official Gazette* on 9 April 2002. This law indicated that the government can borrow as much as the difference between the expenditures specified in the budget and the estimated budget revenues (Çolakoğlu, 2002, p. 23). With the measures specified in the new borrowing law, concerns regarding the sustainability of debts were significantly reduced and fiscal dominance in financial markets declined along with the improvements in fiscal discipline and outstanding public debt (CBRT, 2006, p.18). This regulation paved the way for the sustainability of Turkey's public debts and strengthened Turkey's hand in combating the 'Global Financial Crisis' erupted in the mid-2008.

Low inflation rate: Inflation targeting is basically a choice in economies with low inflation rates aimed at maintaining price stability. In this respect, it is a widespread opinion that the acceptable inflation rate should be around 15% in developing countries like Turkey to be able to implement inflation targeting (Gül, Ekinci, & Gürbüz, 2006, p. 186). However, all of the countries that put this strategy into effect have begun the programme with inflation rates lower than 25% (Şanlı, 2006, p. 40). Turkey became successful only in 2004 in achieving the acceptable inflation rate for implementing inflation targeting. Turkey had inflation rates (CPI) of 29.7% in 2002, 18.4% in 2003, 9.3% in 2004, and 7.7% in 2005; and beginning from 2005, though still high, it achieved a suitable level for the initial stage meeting the criteria of 'low inflation rate' (Eroğlu, 2009, pp. 222–224).

4. Macroeconomic performance of inflation targeting strategy

The argument that inflation targeting positively affects macroeconomic performance has rendered inflation targeting the most preferred monetary policy strategy in recent years by developed and developing countries (Portugal, 2007). The number of studies carried out worldwide on the impact of inflation targeting on macroeconomic performance are not enough, as it is a relatively new strategy and they fail to provide a complete picture about the performance of the strategy. Nevertheless, the common conclusion drawn by numerous studies is that inflation targeting has a positive impact upon macroeconomic variables such as inflation rate and growth rate (Hu, 2003, p. 2). In addition, decline in interest rates and stability in currency have been observed with the rise of credibility of the monetary policy (Petursson, 2004, pp. 26–32).

Among existing studies, while Neumann and Hagen (2002), Hu (2003), Wu (2004) and IMF (2005) obtained the conclusion that inflation targeting has a positive impact upon

macroeconomic performance; Cecchetti and Ehrmann (1999), and Ball and Sheridan (2003) did not obtain such a finding. In these studies, it was observed that the macroeconomic performance improved in inflation targeting countries following the adoption of the strategy; however, either this improvement was not significantly different from the improvements in other countries, or its influence was too little.

On the other hand, the common finding of the studies by Debelle (1999) on Australia and other countries that do and do not implement inflation targeting, by Corbo and Hebbel (2000) on countries of Latin America, by Dickman (2001) on Australia, by Freedman (2001) on Canada, by Schmidt-Hebbel and Tapia (2002) on Chile, by Dodge (2001) on Canada, by Brash (2002) on New Zealand, and by Schmidt-Hebbel and Werner (2002) on Brazil, Chile and Mexico is that the inflation rate and inflation inconstancy declines with the implementation of the inflation targeting strategy. Besides which, the growth rate went up and the growth variability was at a low level. It was thus concluded that inflation targeting assumed the role of a reliable nominal anchor for the monetary policy.

The study carried out by King (1999) on 12 industrialised countries demonstrated that the inflation targeting strategy could reduce inflation without causing a decline in production. In the study of Jones and Mishkin (2003) on the transition economies of Poland, Hungary and Czech Republic, it was argued that it is still too early to draw a conclusion regarding the success of inflation targeting. In addition, it was observed in transition economies that the target can often be reached and serious achievements were made in reducing the inflation rate; however, the inflation variability was observed to be high. In the study of Fraga, Goldfajn, and Minella (2003) on emerging markets, it was concluded that inflation targeting was relatively successful. On the other hand, the study carried out by Karaca (2006) on 122 developing countries demonstrated that inflation targeting has a positive but weak impact on inflation performance, and that it has no effect on growth performance.

In the study of Kara and Orak (2008), the course of medium-term inflation expectations in the first three years of open inflation targeting in Turkey were investigated, and it was observed that the expectations did not go out of control although the inflation rate had been significantly above the targets for a long time and that the expectation of a decline in the inflation rate in the medium-term had always been prevalent. Moreover, Akyazı and Ekinci (2008) suggested that the inflation targeting strategy had had a positive impact upon inflation and growth in developing countries including Turkey. In this respect, it was concluded that significant improvements have been observed in inflation and growth in Turkey when compared to the period before the adoption of the strategy. According to the study of Işık and Duman (2008, pp. 83–84), thanks to the floating exchange rate regime implemented as a requirement of the inflation targeting strategy, the intervention of central banks in the exchange rate market went down and the effectiveness of the monetary policy increased. When considering country practices, including Turkey, it was determined that central banks, whose credibility increased thanks to inflation targeting, implemented effective monetary policies both in reducing inflation and in supporting growth. On the other hand, in the face of the economic picture which emerged after the 2008 Global Financial Crisis, countries that implemented inflation targeting including Turkey were able to produce more resilient policies and this paved the way for reducing the infection of macroeconomic indicators (CBRT, 2008; Eroğlu & Eroğlu, 2010, pp. 61–70).

5. Performance analysis of inflation targeting strategy in Turkey

5.1. Aim and anticipation

The aim of this study is to test through and econometric model whether the argument that inflation targeting positively influences macroeconomic performance is valid in the case of Turkey or not. It is anticipated that the research will find better performances for the macroeconomic variables of inflation rate, growth rate, rate of change in exchange rate and nominal interest rate for the period following the adoption of the inflation targeting strategy in Turkey, compared to earlier periods.

In the literature, inflation targeting strategy is successful on macroeconomic performance before the 2008 Global Financial Crisis. However, the 2008 Crisis has shown that inflation targeting strategy is insufficient alone in assuring price stability and macroeconomic stability, giving rise to the worries about financial stability in the markets. Thus, the central banks of many countries all over the world have taken additional precautions for supporting both price and financial stability after the outbreak of the 2008 Crisis. The present study is focused on the relationship between macroeconomic and inflation targeting variables.

5.2. Method and data set

In the analysis; variables of inflation rate, growth rate, rate of change in exchange rate and nominal interest rate (deposit interest), which are frequently used as macroeconomic performance measures, were used. These variables were subjected to multiple linear regression analysis based on the Least Squares Method (LSM) for the periods prior to and following the adoption of the inflation targeting strategy. In the literature, this method is used for assessing the performance analysis (Ball & Sheridan, 2003; Fraga et al., 2003). Compared to alternative estimation methods, the method of least squares provides important advantages in terms of finite and infinite sample properties. Among the advantages is the fact that the estimator in this method is the best linear unbiased estimator (BLUE). Here, it will be useful to explain a point. In the literature, descriptive methods are used for analysing the inflation-targeting performance although we have used the LSM in the present research. For instance, Jones and Mishkin (2003), Fraga et al. (2003), Hu (2003), Işık and Duman (2008) and Akyazı and Ekinci (2008) have used scatter plots along with mean and standard deviations and concentrated mostly on statistically descriptive analyses. For the sample size data of the study, data provided by Turkish Statistical Institute (TSI), State Planning Organisation (SPO), Undersecretariat of Treasury and CBRT were used. The following data set was used:

Inflation rate: Annual % change based on CPI
Growth rate: Annual % change in GDP in constant prices
Exchange rate: % change in the monthly average value of the buying rate of USD (CBRT exchange rates determined the previous day)
Interest rate: CBRT one-month maturity weighted interest rate on deposits.

In the study, by dividing between periods before (1990–2001) and after (2002–2008:5) the implementation, the strategy's impact on the variables of inflation rate, growth rate, rate of change in exchange rate and nominal interest rate and its relative performance against the policies implemented prior to inflation targeting were investigated. In the division of periods, the year 1990, when CBRT began to implement an official monetary policy, became decisive for the period prior to the implementation. For the post-implementation period,

Table 1. Macroeconomic variables in pre- and post-inflation targeting periods in Turkey.

INFLATION TARGETING	Pre-Inflation Targeting Period (1990–2001)		Post-Inflation Targeting Period (2002–2008:5)	
	Mean	Standard Deviation	Mean	Standard Deviation
Inflation Rate (%)	73.73	17.93	17.74	15.24
Growth Rate (%)*	3.59	5.51	6.78	1.69
Nominal Interest Rate (%)**	65.03	28.81	28.64	11.43
Rate of Change in exchange Rate (%)***	4.72	6.01	−0.12	3.67

*As of the years 2002–2007 for the post-targeting period.
**Data of CBRT one-month maturity weighted interest rate on deposits.
***Based on % change in monthly average values of buying rate of USD by CBRT.
Source: Calculated by using the data of TSI, SPO, Undersecretariat of Treasury and CBRT.

on the other hand, the year of 2002when policies based on inflation targeting began to be pursued in Turkey, was taken as the basis. The end date of the post-implementation period was taken as 2008:5, because Turkey started to feel the effects of the 2008 Global Financial Crisis beginning from the second half of 2008.

5.3. Econometric analysis

In order to see the influence of the inflation target on the performance of the selected macroeconomic variables, it is firstly necessary, in terms of gaining a general opinion, to examine the mean and standard deviation values of the inflation rate, growth rate, rate of change in exchange rate and nominal interest rate in the periods before and after inflation targeting. In this analysis; Means give the arithmetic mean values of the selected macroeconomic variables for the periods before and after inflation targeting; whereas Standard deviation refer to the measures of variability of these macroeconomic variables.

A preliminary analysis based on the data in Table 1 suggests that, with the implementation of inflation targeting in Turkey, the average inflation rate went down from 73.73% to 17.74%, whereas the average growth rate went up from 3.59% to 6.78%. On the other hand, while the average rate of change in exchange rate declined from 4.72% (increasing) to −0.12% (decreasing), the nominal interest rate decreased from 65.03% to 28.64%. The standard deviation values of these macroeconomic variables indicate that variability declined after the implementation of inflation targeting. The measure of variability declined in the inflation rate from 17.93% to 15.24%, in the growth rate from 5.51% to 1.69%, in the rate of change in exchange rate from 6.01% to 3.67% and finally in the nominal interest rate from 28.81% to 11.43%; which means that these macroeconomic variables became more consistent. According to this preliminary analysis, the implementation of inflation targeting reduces inflation, enhances growth, decreases the rate of change in exchange rate (even to a negative rate) and reduces interest rates. Moreover, the strategy also reduces the variability of these macroeconomic variables. It could therefore be concluded that the implementation of inflation targeting in Turkey positively influences the macroeconomic performance. However, this preliminary analysis does not fully reveal the dimensions where these macroeconomic variables were influenced by inflation targeting. Therefore, a detailed analysis is needed.

Model: The following multiple linear regression equation was used for measuring the impact of inflation targeting in Turkey on macroeconomic performance, provided that it was administered to each of the variables separately[4]:

$$Y_t = \beta_0 + \beta_1 D_t + \beta_2 t_t + u_t \quad (1)$$

Here, Y_t is the macroeconomic variable with testable performance; D_t is target inflation (the value of inflation targeting as the dummy variable is 0 for the pre-targeting 1990–2001 period and 1 for the post-targeting 2002–2008:5 period); t_t is time trend; β_0 is constant term; β_1 is the coefficient of the dummy variable (D_t); β_2 is the change in the Y_t dependent variable in case of one unit increase in time, and; u_t denotes the error terms distributed as in $u_t \sim N(0, \sigma^2)$.

In a regression analysis based on this equation, the coefficient of D_t variable will give the effect of β_1 inflation targeting on Y_t variable. Thus, the β_1 parameter is the basic coefficient of the present study. We will use the LSM for testing if the sign and size of this parameter will satisfy our expectations.

Unit Root Tests of Series: In analyses where time series are used, going straight to analysing the model without checking whether the series are stationary or not would be an incorrect approach. It is necessary to see first whether series are stationary or not (Tarı, 2005, p. 393). Non-stationary series might not only create serious problems for the researcher but also cause deceptive conclusions. If two-time series are not stationary, even though a significant correlation does not exist between them, it may cause the R^2 value, which shows the correlation between the variables when the regression is set, to be very high. This is known as spurious regression. This situation may stem from a strong tendency or a trend to the same direction that time series have (Enders, 1995, pp. 155–195).

Gujarati (1999, pp. 712–713) defines stationarity as:

> … a stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed.

Based on the definition, any Y_t series is assumed to have following characteristics:

$$\text{Mean} \quad : E(Y_t) = \mu \quad (2)$$

$$\text{Variance} \quad : \text{Var}(Y_t) = \gamma_0 = E(Y_t - \mu)^2 \quad (3)$$

$$\text{Covariance} \quad : \text{Cov}(Y_t, Y_{t+k}) = \gamma_k = E[(Y_t - \mu)(Y_{t+k} - \mu)] \quad (4)$$

A Y_t time series that has the characteristics above is defined as a weak stationary stochastic process. Weak stationarity is considered enough for most applications.

There are several ways to detect stationarity. The most common of them is the unit root test. By investigating the presence of unit root in the time series, the series is decided whether to be stationary or not. It is stationary if a time series does not have unit root, and it is non-stationary if it does. Although there are varieties of unit root tests, the most common one is Augmented Dickey-Fuller (ADF) unit root test, which was developed by Dickey and Fuller (1979, pp. 427–431; 1981, pp. 1057–1072). The regression equation used in the ADF test is generally written as follows:

$$\Delta Y_t = \mu + \beta t + \delta Y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta Y_{t-i} + \varepsilon_t \tag{5}$$

Here, ΔY_t is the first difference of the variable tested for stationarity, t is trend variable and ΔY_{t-i} is delay difference term. Delay difference terms are added to the equation for avoiding the auto-correlation problem in the error term. No auto-correlation problems must emerge in the estimated model so that the ADF test can yield healthier results (Karaca, 2005, p. 5). K symbolises the length of lag and is usually determined by The Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC). ε_t is stochastic error term and $\varepsilon_t \sim IID(0, \sigma^2)$. Unit root test is used for determining if the (δ)() parameter of the Y_{t-1} variable is equal to zero. If $\delta = 0$, the series includes unit roots and it is non-stationary. If $\delta \neq 0$ (i.e., $\delta < 0$) the series contains no unit roots and it is stationary.

The Philips–Perron (PP) (1988) test is another unit root test that is used for testing the stationarity of series. Different from the Dickey and Fuller (1979) test, a non-parametric test was developed for the PP test. Philips and Perron regulated the parameter in the AR(1) process that is described as follows:

$$Y_t = \varphi_1 Y_{t-1} + \varepsilon_t \tag{6}$$

Thus, they wrote the formula as follow:

$$Z_\alpha = T(\hat{\varphi}_1 - 1) - CF \tag{7}$$

Here, CF is the correction factor. The correction factor is calculated as follow:

$$CF = \frac{0.5(s_{T\ell}^2 - s_\varepsilon^2)}{\sum_{t=2}^{T} (Y_{t-1} - \bar{Y}_{-1})^2 / T^2} \tag{8}$$

Before applying unit root test to the variables used in the study, it will be useful to explain the model structures that will be used in the tests. Maximum length of lag is determined as 9 in the unit root test application and we have used the SIC for selecting the length of lag. The t-test results have determined our decision on whether we should incorporate T+S or S only to the unit root equation. For analysing the presence of unit roots,[5] T and/or S has been included in the equation if significant at least at 10% level. Table 2 shows all variables, except for the inflation variable, contain no unit roots and they are stationary. However, the inflation variable has become stationary after processed with the first difference of the inflation rate series.

Table 2. ADF and PP unit root test results of variables.

	LEVEL (FIRST DIFFERENCE)			LEVEL (FIRST DIFFERENCE)		
VARIABLE	ADF	Lag	T, S	PP	Lag	T, S
Inflation Rate	−2.7406/(−9.6918*)	1	T+S	−2.2555/(−9.4718*)	1	T+S
Growth Rate	−5.0730*	0	S	−5.0730*	0	S
Rate of Change in Exchange Ratio	−9.9438*	0	T+S	−9.7617*	5	T+S
Interest rate	−5.1804*	1	T+S	−8.1779*	6	T+S

*is stationary at 1% significance.
Source: Calculated by the authors.

5.4. Analysis results

The analysis of the linear regression model is based on several assumptions. Among these assumptions are the normal distribution or error terms, zero mean of error terms, and for error terms not to have the problems of heteroskedasticity and autocorrelation (Serper, 2000, pp. 220–225). The normal distribution of error terms means for them to exhibit symmetrical division around their own means in the form of a bell-shaped curve. For error terms to have a zero mean refers to that the average of error terms equals to zero when all values of the error term are considered for each value of the variable (Serper, 2000, p. 220). For error terms not to have the problem of heteroskedasticity means that there is no correlation between error terms variance and the independent variable (Tarı, 2005, p. 173). For error terms not to have the problem of autocorrelation is, finally, based on the assumption that no correlation exists between the sequential values of error terms (Tarı, 2005, p. 195). Therefore, it was tested whether or not the error terms belonging to each macroeconomic variable possess such characteristics. In the tests pertaining to the models, it was determined that the error terms (residuals) were not distributed normally and that the parameters were biased in the analysis of the estimated model. This is an undesired situation. The solution of such a problem is often attributed to the *Central Limit Theorem* assumption. As required by the theorem, it is assumed that error terms will exhibit normal distribution as their sample size increases (Çil, 2004, p. 207). Thus, such a problem will be eliminated as the number of observations about inflation targeting rises. In other words, the sample distribution is expected to become normal as its size increases. On the other hand, in case the problems of heteroskedasticity and autocorrelation are observed in the analysis of the model, the model analysing procedure of Newey-West HAC (Heteroskedasticity and Auto Correlation), which is effective in removing this problem, was preferred (Aklan & Nargeleçekenler, 2008, p. 156).

Using the above linear regression equation; the impact of the implementation of inflation targeting in Turkey on inflation rate, growth rate, rate of change in exchange rate and nominal interest rate was tested and the findings below were obtained. In order to save the series in econometric analyses from possible heteroskedasticity and autocorrelation, series' logarithmic transformations are taken (Tarı, 2005, p. 382). For this reason, in the analysis, series' logarithmic transformations were used.

Model 1 (Inflation Rate): CPI-based inflation rate was firstly found to be non-stationary. Therefore, the first difference (D inflation) of the inflation rate data was taken and stationarity was achieved. According to the regression analyses performed for this data (Table 3); the coefficient of the dummy variable was negative as expected, which means that it had an impact to decrease inflation. It is statistically significant at the level of 1%. This situation suggests that the inflation targeting strategy positively influences the inflation rate performance, depending on the decline of the inflation rate. The coefficient of the D dummy variable (inflation targeting) was found to be –1.492. This means that the inflation rate in the period in which inflation targeting is implemented is lower than that in the period in which inflation targeting is not implemented by 1.492% on average. T (time) independent variable coefficient was found to be negative as expected, but not statistically significant. The adjusted R^2 value was found to be 0.23; which means that 23% of the change experienced in the inflation rate is explained by the inflation targeting strategy, while the remaining 77% needs to be attributed to other factors. Besides, the regression model was statistically significant at the significance level of 1% according to F test. These findings suggest that the inflation targeting strategy had a positive impact on the inflation rate as expected; however, this impact was not strong.

Table 3. Regression analysis results of macroeconomic variables.

	MODEL 1 Dependent Variable Log (D INFLATION)	MODEL 2 Dependent Variable Log (GROWTH)	MODEL 3 Dependent Variable Log (EXCHANGE)	MODEL 4 Dependent Variable Log (INTEREST)
Intersection (constant term)	0.488428	1.231129	1.145713	4.043374
Inflation Targeting (D)	−1.492413* *(-3.113279)*	−0.405775 *(-0.450271)*	−1.201500 * *(-3.121378)*	−0.946979* *(-4.621545)*
Time Variable (T)	−0.000432 *(-0.129818)*	0.068222 *(0.853506)*	0.003161 *(1.256674)*	0.001055 *(0.774437)*
R^2	0.251131	0.083273	0.145652	0.607378
Adjusted R^2	0.236590	−0.069515	0.135169	0.603776
F Test	17.27041*	0.545022	13.89441*	168.6208*
D W	1.763868	3.086442	0.747749	0.339813

Notes: Problems of autocorrelation and heteroskedasticity were observed in Model 3 and Model 4; and the *Newey-West HAC (Heteroskedasticity and Auto Correlation)* procedure was employed. Parenthetical values are t statistics.
*Points to statistical significance at the level of 1%.
Source: Calculated by the authors.

Model 2 (Growth Rate): According to the regression analysis results conducted for the annual percentage rise in GDP (in constant prices) (Table 3), the coefficient of the dummy variable D (inflation targeting) was expected to be positive; however, it was found to be negative. The analysis suggested that the implementation of inflation targeting did not have a statistically significant correlation with the growth performance. T (time) independent variable coefficient was found to be positive as expected; but not statistically significant. The adjusted R^2 value was found to be -0.069515; which can be interpreted as zero. This suggests that the power of the inflation targeting strategy to explain the change in the growth rate is zero. The regression model was not found to be statistically significant according to F test. This suggests that there does not exist a correlation between the period in which the inflation targeting strategy is implemented and growth.

Model 3 (Rate of Change in Exchange Ratio): In the regression analysis performed for the rate of change in exchange rate (Table 3) the coefficient of the dummy variable was found negative as expected. The coefficient of the dummy variable was –1.201; and statistically significant at the level of 1%. This means that the rate of change in exchange rate in the period in which inflation targeting is implemented is lower than that in the period in which inflation targeting is not implemented by 1.20% on average (this decrease in the exchange rate is significant in that it contributed indirectly to the suppression of inflation). T (time) independent variable coefficient was found to be positive, contrary to the expectations, and it was statistically insignificant. The adjusted R^2 value was found to be 0,13; which means that 13% of the change experienced in the exchange rate is explained by the inflation targeting strategy, while the remaining 87% needs to be attributed to other factors. The regression model was statistically significant at the significance level of 1% according to F test. These findings suggest that there existed an expected correlation between the inflation targeting strategy and the change in the exchange rate; however, this correlation was weak.

Model 4 (Nominal interest Rate): In the regression analysis performed for the nominal interest rate data (Table 3), the coefficient of the dummy variable was found negative as expected. This finding demonstrates that inflation targeting decreased the interest rate and thus increased performance. The coefficient of the dummy variable was found to be –0.946979; and statistically significant at the level of 1%. This means that the nominal interest rate in the period in which inflation targeting is implemented is lower than that in the period in which inflation targeting is not implemented by 0.94% on average. T (time) independent variable coefficient was found to be positive, contrary to the expectations, and it was statistically insignificant. The adjusted R^2 value was found to be 0.60; which means that 60% of the change experienced in the nominal interest rate is explained by the inflation targeting strategy, while the remaining 40% needs to be attributed to other factors. The regression model was statistically significant at the significance level of 1% according to F test. These findings suggest that there existed an expected and strong correlation between the inflation targeting strategy and interest rates.

6. Conclusion

The impacts of inflation targeting on macroeconomic performance have recently been studied by several researchers. The common result presented by numerous studies is that, with the implementation of inflation targeting, the inflation rate goes down, the variability of inflation decreases, growth rate improves and its variability decreases. In addition, interest

rates go down and the exchange rates gain stability. In this study, the impact of inflation targeting in Turkey on the macroeconomic performance within the framework of the above variables was selected as the research topic. With an empirical analysis and through a comparison between the periods before and after the adoption of the inflation targeting strategy, its impacts on the inflation rate (CPI), the growth rate (GDP in constant prices), the rate of change in exchange rate (USD buying rate) and the interest rate (nominal interest rate on deposits) were subjected to a regression analysis based on the LSM. It was concluded that the inflation targeting strategy had a positive impact on Turkey's macroeconomic performance except for the growth performance. This impact was weak in the inflation and exchange rates, while strong in the interest rate. This result supports the suggestion that there is a similar relationship between inflation and interest rate.

In this respect, the thesis that 'the inflation targeting strategy positively influences macroeconomic performance' was proved except for the growth rate (there is neither a positive nor a negative impact on growth). When this research is repeated in the future, findings regarding the impact of inflation targeting on macroeconomic performance might be different than those of this study, depending on the rise in the number of observations.

Notes

1. While the classical view in monetary policy analyses deals with the stability of nominal variables such as prices, money supply, exchange rate and wages; the Keynesian approach pays attention to the stability of a structure that involves real variables such as production, investment and consumption.
2. This convergence is called new neoclassical synthesis in that it brings Classical and Keynesian elements together, similar to the neoclassical synthesis approach developed in the early 1960s by economists like J.R. Hicks, P. Samuelson and D. Patinkin. Among the pioneers of the approach are M. Goodfriend, R.G. King, R. Clarida, J. Gali and M. Gertler.
3. In an interview, Deputy Governor of CBRT, Erdem Başçı has stated: The inflation targeting regime began to be practically implemented in Turkey in 2002 with developments like transition to floating exchange rate regime, making short-term interest rates policy instruments, endowing CBRT with independence through the amendment in CBRT Law by the Law No 4651, assuming price stability as the only objective, targeting a certain inflation rate, etc. Therefore, it would be right to take the year of 2002 as the starting year for any performance analysis.' In Başçı's words, regulations other than the above mentioned main instruments are kind of *'accessories of the strategy'*. E. Başçı, (personal communication, February 12, 2008).
4. Ball and Sheridan (2003) and Fraga et al. (2003) have followed similar procedures.
5. The critical values here are not the table values. They are the Dickey and Fuller (1981) critical values.

Disclosure statement

No potential conflict of interest was reported by the authors.

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